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Cyclical variation in vacancy durations and vacancy flows

An empirical analysis*

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This paper presents an empirical analysis of vacancy durations and vacancy flows in the Netherlands over the years 1980–1988. We distinguish vacancies according to required occupation and educational levels. We derive estimates of average vacancy durations, and we use these to derive estimates of vacancy flows. We find that vacancy durations generally increase with the required educational level. Moreover, vacancy flows tend to be more responsive to the business cycle at lower educational levels, while vacancy durations are more responsive at higher educational levels. The number of vacancies generated by employers has not decreased during the recession in the early 80s, which points to a dominant role of the supply of applicants in explaining the cyclical pattern of vacancy durations.

1. Introduction

This paper is a contribution to the limited literature there is on vacancies. We shall study the period of time that an employer needs to fill a vacancy, in other words the duration of the vacancy. The vacancy duration is a measure of the tightness of the labor market from the perspective of the employer, just as the unemployment duration is a measure of the tightness of the labor market from the perspective of the job seeker. There are few studies of vacancy durations. Studies using Dutch vacancy data are Van Ours (1989) and Van Ours and Ridder (1990). The only other studies we know of are Beaumont (1978) and Roper (1988). This paper differs from these studies in a number of ways.

Firstly, they focus on vacancy durations. We also consider vacancy flows, i.e. the number of vacancies filled in a period which, in a steady state, is

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equal to the number of vacancies generated in that period. Secondly, they study a cross-section of vacancy durations. We study the cyclical pattern of vacancy durations and vacancy flows. Hence, our study is complementary to these studies.

The plan of the paper is as follows. In section 2 we provide some theoretical background. The data which are from the Dutch Central Bureau of Statistics (CBS) are discussed in section 3. The statistical model used in this study is introduced in section 4. Section 5 contains the empirical results. Finally, in section 6 we draw some conclusions.

2. Vacancy durations and employer search

There are numerous empirical studies of unemployment durations. Moreover, there is a well-developed theory, job search theory, that can be used, either to formulate structural models for the duration of unemployment spells or to interpret the results of reduced form models [see Mortensen (1986) for a survey of job search theory]. According to job search theory the search strategy of the unemployed job seeker is characterized by a reservation wage (or more generally a reservation value). A job offer with a wage (or value) that exceeds the reservation wage (value) is accepted, all other offers are turned down. Search is sequential: Job offers arrive one by one and are accepted or rejected upon arrival. The probability of finding a job in some time interval is equal to the product of the probability of obtaining a job offer and the probability that a job offer is accepted.

A number of empirical studies consider the decomposition of the probability of finding a job into the probability of obtaining an offer and the acceptance probability [e.g. Narendranathan and Nickell (1985), Ridder and Gorter (1986), Lancaster and Chesher (1983) and van den Berg (1988)]. Many authors conclude that the acceptance probability is almost one, i.e. the job seekers accept the first job offer. This is consistent with the finding of Barron, Bishop and Dunkelberg (1985) that 90% of the employers who had vacancies, needed only one offer to fill a vacancy.

These results imply that the decision whether a contact between an employer and a job seeker results in a job is predominantly made by employers and not by job seekers. Hence, the re-employment probability of unemployed job seekers is the product of the probability of a contact which depends on the search intensities of unemployed job seekers and firms, and the probability that the unemployed job seeker is acceptable to the employer that he or she has contacted. This view of search is at odds with the usual sequential search model of job search theory.

The hiring rate, i.e. the rate at which vacancies are filled, is the product of the rate at which job seeker-employer contacts are made, and the probability that an applicant is acceptable to the employer. Hence, the study of

unemployment durations or more generally spells of job search, and the study of vacancy durations are similar. In both cases we deal with search intensities of job seekers and employers, and acceptance decisions of employers. However, in the case of unemployment duration we take the perspective of the job seeker, and in the case of vacancy durations we take the perspective of the employer.

Employers do not hire the first applicant. This leaves the question which search strategy is used by the employers. This study concentrates on the outcome of employer search, i.e. the rate at which vacancies are filled, and we shall not attempt to interpret our results in the light of a detailed theory of employer search. In particular, we shall not decompose the probability of filling a vacancy into the probability of obtaining an applicant, which is determined by the search intensities of job seekers and employers, and the probability that this applicant is found suitable for the job. This is the subject of a companion paper [Van Ours and Ridder (1990)].

We think of unemployment durations as periods of job search. If an unemployed person stops searching for a job, we usually consider that as a withdrawal from the labor market. The spell of unemployment also ends when a job is found. However, if unemployment is anticipated, then the period of job search may start before the spell of unemployment begins. The vacancy durations that are analyzed in this study can also be seen as search periods. The vacancy duration starts as soon as the employers start looking for a (new) employee. This may be before the present employee has left, although legal restrictions on advance hiring and the high costs associated with paying double wages for the same job, make it unlikely that the search starts long before the present employee leaves (According to the CBS 1988 vacancy survey 32% of all vacancies referred to occupied jobs). A vacancy duration ends when a suitable (new) employee is found. In the surveys that are used in this paper the definition of a vacancy allows an interpretation of a vacancy duration as a search period.

3. The data

The CBS vacancy duration data analyzed in this study were collected by yearly vacancy surveys among employers. The first survey dates back to October 1980, and subsequent surveys were conducted in October (1981–1983), September (1984) or January (1986–1988). The vacancy survey is a stratified random sample of some 20,000 employers. The stratification is by size of establishment and by industry. Government agencies (central and local), educational institutions and temporal employment agencies are excluded from the survey. The employers in the surveyed population account for 80–85% of total employment.

With an elusive concept as a vacancy it is important how a vacancy is

defined in the survey. The employers were asked whether they had vacancies that they wanted to fill either immediately or as soon as possible. It was pointed out to the employers that they should also consider vacancies for which there are applicants, vacancies for which the selection procedure will take so much time that it is impossible to fill it in a short time interval and vacancies which they intend to fill with a temporary worker. This definition implies that a vacancy starts as soon as an employer starts looking for a (new) employee, and that it ends when a suitable employee is found. Hence the vacancy duration as measured in the survey coincides with the search period that is needed to fill the vacancy. The incomplete vacancy duration at the time of the survey was obtained by asking when the employer started looking for a (new) employee. We do not know the exact incomplete vacancy duration, because this duration was recorded in intervals: 0–1, 1–3, 3–6 and 6+ months.

The employers were asked to give a few characteristics of the vacancies. In this study we distinguish vacancies according to the kind and level of education that is required. We only consider vacancies that require a technical or a clerical/business training. In the Netherlands there is formal vocational training at four levels: lower, intermediate, higher and university. We shall distinguish vacancies accordingly.

Hence our data consist of the number of vacancies stratified by duration interval and by required kind and level of training and by year.

Fig. 1 shows the evolution of the total number of vacancies and the number of vacancies that require a clerical/business or a technical training over the period October 1980–January 1988.

The number of vacancies decreases until 1983 and rises after that year to a level that exceeds that in 1980. As shown in table 1 the extent of the increase after 1983 differs between the required educational levels, the increase for those vacancies that require a higher vocational training being much larger than the average increase.

4. The statistical model

In this paper we analyze grouped duration data. A similar analysis of grouped unemployment durations was conducted by Kooreman and Ridder (1983). We refer to that paper for technical details. The distribution of an individual vacancy duration, which is indexed by i, is fully characterized by its hazard rate. We choose a Proportional Hazard model as introduced by Cox (1972), i.e. the hazard rate has the following form

$$\lambda_i(t) = \exp(X_i'\beta)\psi(t)v_i. \tag{4.1}$$

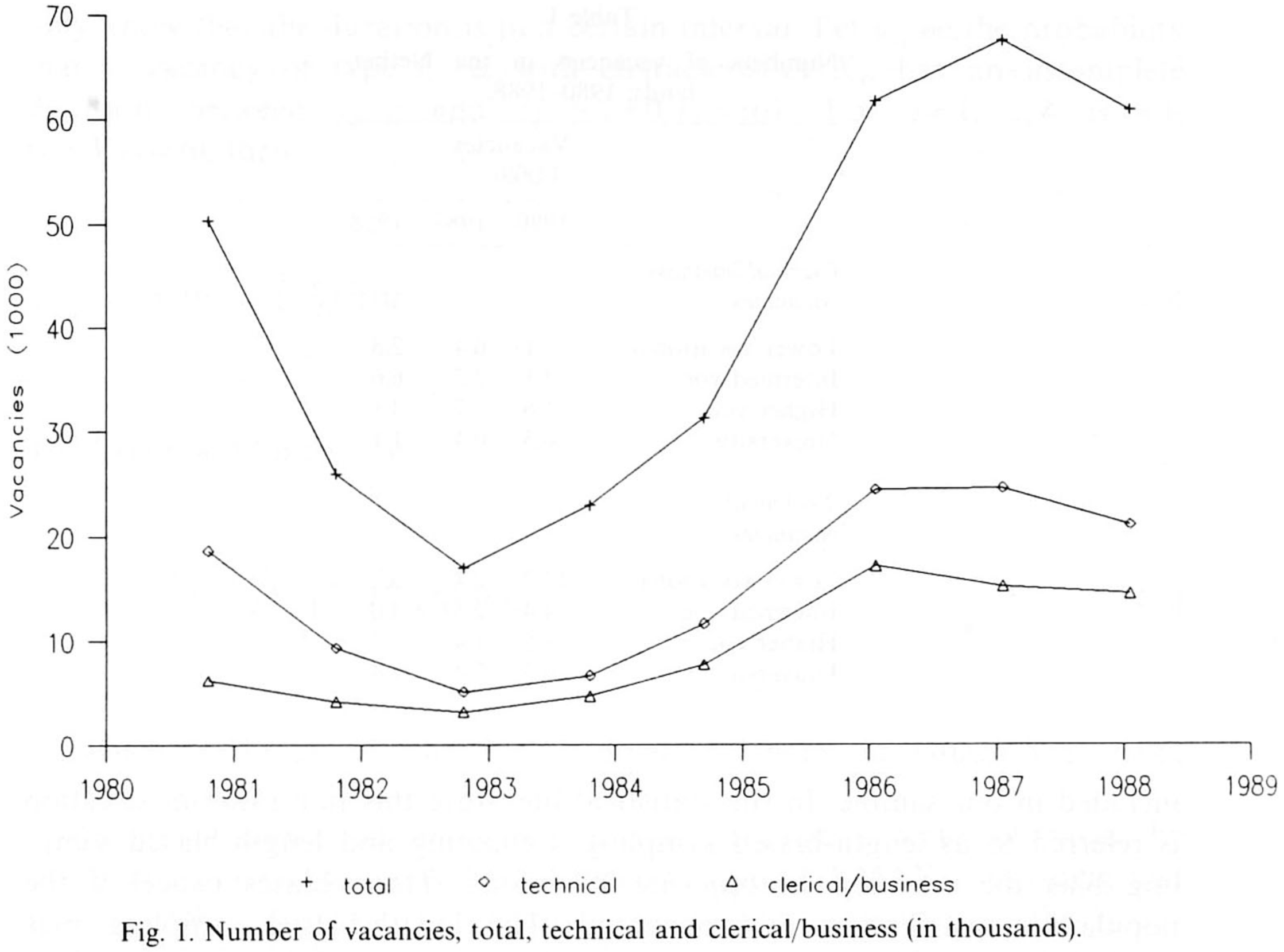

Fig. 1. Number of vacancies, total, technical and clerical/business (in thousands).

In (4.1) X_i is a vector of (exogenous) explanatory variables, β is a vector of regression coefficients, the random variable v_i captures the unobserved heterogeneity not accounted for in x_i and $\psi(t)$ describes the duration dependence of the hazard. We shall assume that $\psi(t)$ has the Weibull form, i.e.,

$$\psi(t) = \alpha t^{\alpha - 1}, \tag{4.2}$$

and that v_i follows a Gamma distribution with mean 1 and variance σ^2. In Ridder's (1988) classification this model is a Mixed Proportional Hazard (MPH) model.

The statistical analysis is complicated by the fact that we do not observe the completed durations. All durations are censored at the date of the survey. Moreover our sample is not a random sample from the population of (completed) durations, but a random sample from the stock of vacancies at a particular moment. Because we sample from the stock, we have that vacancies that have been open for a longer period are more likely to be

Table 1

Numbers of vacancies in the Netherlands; 1980–1988.

	Vacancies (1,000)		
	1980	1983	1988
Clerical/business vacancies			
Lower vocational	1.1	0.4	2.8
Intermed voc	3.1	2.2	6.6
Higher voc	1.6	1.7	4.1
University	0.5	0.4	1.1
Technical vacancies			
Lower vocational	12.2	2.4	8.0
Intermed voc	4.4	2.5	8.0
Higher voc	1.5	1.4	3.7
University	0.5	0.4	1.4

included in our sample. In the statistical literature this non-random selection is referred to as length-biased sampling. Censoring and length-biased sampling bias the duration in opposite directions. These biases cancel if the population distribution is exponential. The length-biased sampling bias dominates if there is decreasing duration dependence, and the truncation bias dominates if the duration dependence is increasing. The correct density of length-biased incomplete spell (as a function of the density of complete spells) can be found in Ridder (1984) and we use his expression. The only assumption made in the derivation is that the rate at which vacancies are generated is constant in the period preceding the dates of the surveys.

The density of an incomplete and length-biased vacancy duration [Kooreman and Ridder (1983)] is:

$$\tilde{h}_i(t) = \alpha(\sigma^2\phi_i)^{1/\alpha}(1+\sigma^2\phi_i t^\alpha)^{-1/\sigma^2}/B(1/\alpha, 1/\sigma^2 - 1/\alpha), \tag{4.3}$$

in which $B(\cdot,\cdot)$ denotes the Beta-function:

$$B(1/\alpha, 1/\sigma^2 - 1/\alpha) = [\Gamma(1/\alpha)\cdot\Gamma(1/\sigma^2 - 1/\alpha)]/\Gamma(1/\sigma^2), \tag{4.4}$$

and $\Gamma(\cdot)$ denotes the Gamma-function.

We do not observe the incomplete vacancy duration directly. Instead we

only know that the duration is in a certain interval. Let p_{ij} be the probability that a vacancy of type i, i.e. with characteristics X_i, has an incomplete duration between t_{j-1} and t_j $(t_0=0, t_4=\infty)$. For $j=1,\ldots,4$ $(t_1=1, t_2=3, t_3=6)$, then

$$p_{ij}(\theta)=\int_{t_{j-1}}^{t_j} \tilde{h}_i(t)\,\mathrm{d}t. \tag{4.5}$$

The likelihood function is

$$L(\theta)=\prod_{j=1}^{4}\prod_{k=1}^{4}\prod_{l=1}^{8} p_{jkl}^{n_{jkl}}(\theta), \tag{4.6}$$

in which $j=$index of duration interval, $k=$index of educational level, $l=$index of year.

Maximum likelihood estimates of the parameters were obtained by minimizing the minus-loglikelihood function using GRMAX [Bekkering and Ridder (1986)]. For the (numerical) integration in (4.5) we used the NAG-routine D01BAF which is based on a Gauss-Legendre quadrature algorithm.

The vector of regressors X contains the following variables:

(i) A set of dummy variables that indicate the year of the survey.
(ii) The required educational level.
(iii) The vacancy rate (vacancies as a % of the labor force) by educational level at the survey dates.

The use of the vacancy rate as an explanatory variable seems to be problematic. In stationary equilibrium the vacancy rate equals the product of the inflow rate in the stock of vacancies and the average duration of a vacancy. However, the (possibly time-varying) regressors in a duration model need not be strictly exogenous. We only require that they are predetermined. To see this it is helpful to think of the process that determines a vacancy duration as a sequence of Bernoulli experiments. If the first Bernoulli experiment results in a success the vacancy is filled. If it results in a failure we proceed to a second (not necessarily identical) experiment which again may result in a success (the vacancy is filled in the second time period) or a failure (the vacancy duration is longer than the first two periods). Now note that the vacancy rate at any time only depends on the outcome of previous Bernoulli experiments, i.e. the vacancy rate can be considered as predeter-

Table 2

Maximum likelihood estimates MPH model for vacancy durations (standard errors).

	Clerical/business vacancies	Technical vacancies
CONSTANT	−0.34 (0.062)	−1.58 (0.078)
VACANCY RATE	−0.40 (0.032)	−0.34 (0.022)
1980	–	–
1981	1.13 (0.076)	0.75 (0.049)
1982	1.21 (0.084)	1.95 (0.079)
1983	1.32 (0.078)	2.58 (0.089)
1984	1.06 (0.070)	2.25 (0.076)
1986	1.38 (0.086)	2.12 (0.071)
1987	0.99 (0.075)	1.97 (0.068)
1988	1.27 (0.075)	1.73 (0.060)
LOWER VOC	–	–
INTERMED VOC	−0.42 (0.041)	−0.23 (0.023)
HIGHER VOC	−1.13 (0.068)	0.18 (0.034)
UNIVERSITY	−2.05 (0.095)	−0.94 (0.048)
σ^2	1.02 (0.052)	0.84 (0.034)
α	2.25 (0.095)	1.70 (0.054)

mined for the present experiment. Hence, we can use the vacancy rate as a regressor in the hazard.

5. Results

We have estimated the MPH model separately for the vacancies that require a clerical/business orientation and the vacancies that require a technical orientation. The maximum likelihood estimates presented in table 2 show that a larger vacancy rate is associated with a smaller probability that a vacancy is filled. We can interpret this as a congestion effect. The year dummies (the reference year is 1980) show that there has been a considerable increase in the instantaneous probability that a vacancy is filled during the early 80s. There is some evidence of a decrease in the second half of this decade. For the clerical/business vacancies we see that a higher required level of education means a smaller probability of filling a vacancy (the reference level is lower vocational training). Employers take (much) more time to find a suitable candidate for a position that requires a high educational level. This may be a consequence of the high costs of laying-off a highly paid worker. This finding is consistent with the results of Barron, Bishop and Dunkelberg who conclude that the acceptance probability of an applicant decreases with the level of education.

In the case of technical vacancies we do not observe such an easily interpretable pattern. Employers do not take much time to fill a technical vacancy that requires a higher vocational level. Of course, this may be due to

a relatively large arrival rate of job seekers (employed and unemployed) with the required training, which offsets a relatively small acceptance probability.

The estimates also imply that in both cases there is positive duration dependence, i.e. the instantaneous probability that a vacancy is filled increases with the duration of the vacancy. This suggests that employers become less choosy, if a vacancy is open for a long period. Finally note that the estimate of σ^2 implies that there is a substantial amount of unobserved heterogeneity.

We now turn to the implications of our estimates. First we concentrate on the clerical/business vacancies. In fig. 2a we show the evolution of the average complete vacancy durations by educational level. The order of the average durations is as expected. We find a 'bath tub' pattern in the average durations. Note that vacancy durations at higher educational levels are more responsive to labor market conditions. We can decompose the labor market effect into a congestion effect (the effect of the vacancy rate) and a residual effect (the effect of the year dummies, holding the vacancy rate constant). For higher vocational vacancies it appears that the increase in the vacancy duration is entirely due to the congestion effect. This congestion effect is absent for the other educational levels.

Note that in fig. 2a the average vacancy durations in 1980 and in 1987 are almost equal. This implies that the observed increase in the number of vacancies in the second half of the 80s must be due to an increase in the vacancy flow. This is confirmed in fig. 3a. The vacancy flows in this figure are computed by dividing the number of vacancies by the average vacancy durations as given in fig. 2a. Of course, these computed flows are only correct if the number of vacancies is approximately constant over time. As shown in fig. 1 this is obviously not true. However, because the inflow and outflow rates are large relatively to the stock of vacancies, equilibrium is quickly re-established after shocks to either the inflow or the outflow rate.

Note that the vacancy flows at the lower educational levels are more responsive to labor market conditions. We conclude that the increase in the number of vacancies that is observed after 1983 is a consequence of a higher rate of vacancy creation. Moreover the decrease in the number of vacancies that is observed before 1983 is entirely due to a decrease in the vacancy durations.

A similar picture emerges if we study the technical vacancies. From fig. 2b we see that the increase in the average vacancy durations after 1983 has been much smaller for the technical vacancies than for the clerical/business vacancies. If there has been an increase, as in the case of the higher vocational level, then this increase is entirely due to the congestion effect. The corresponding vacancy flows are shown in fig. 3b. The increase is spectacular except for the vacancies that require a university degree. The increase in the number of vacancies is entirely due to the increase in the

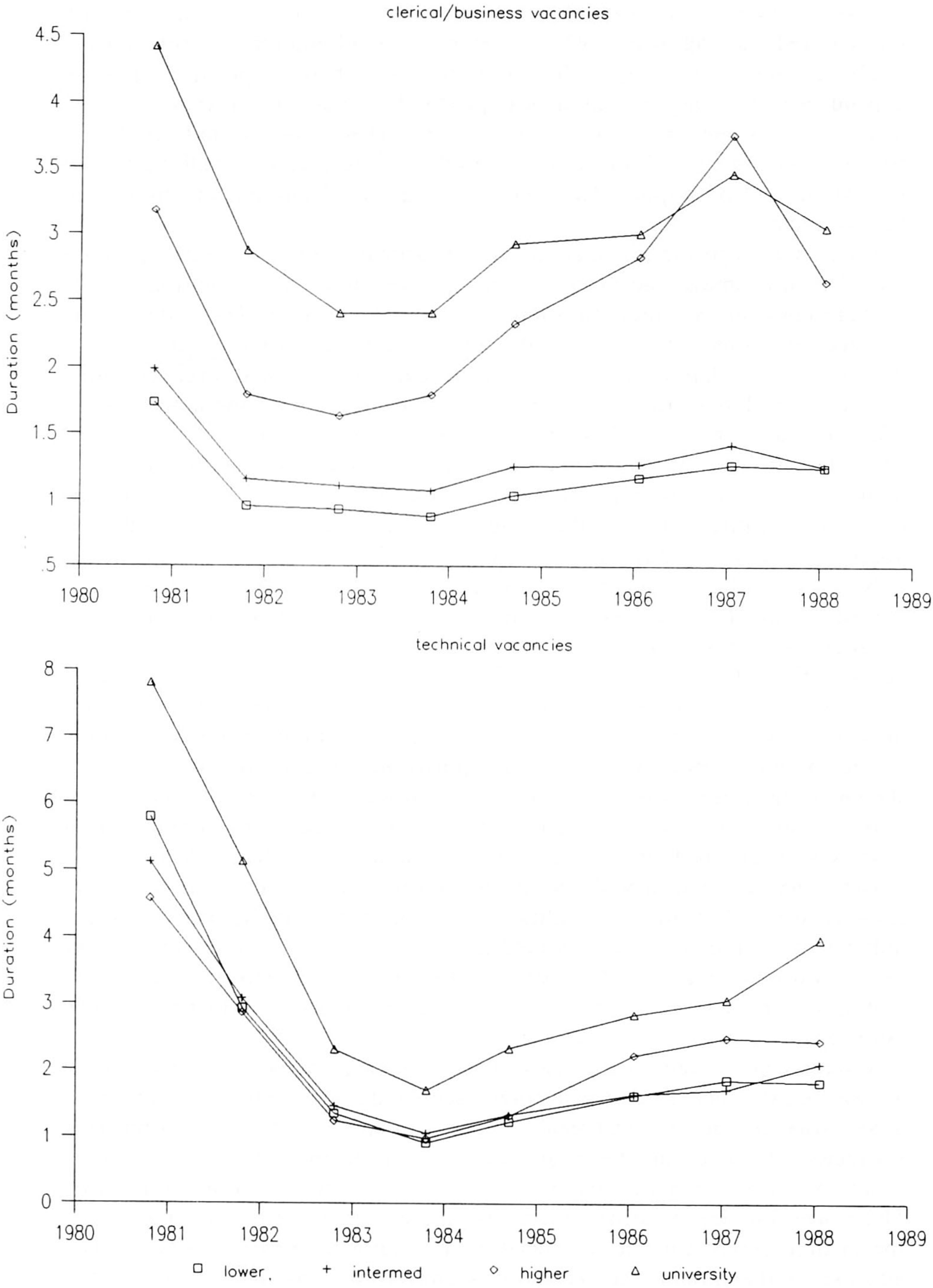

Fig. 2. Average complete durations of clerical/business (a) and technical (b) vacancies by educational level (months).

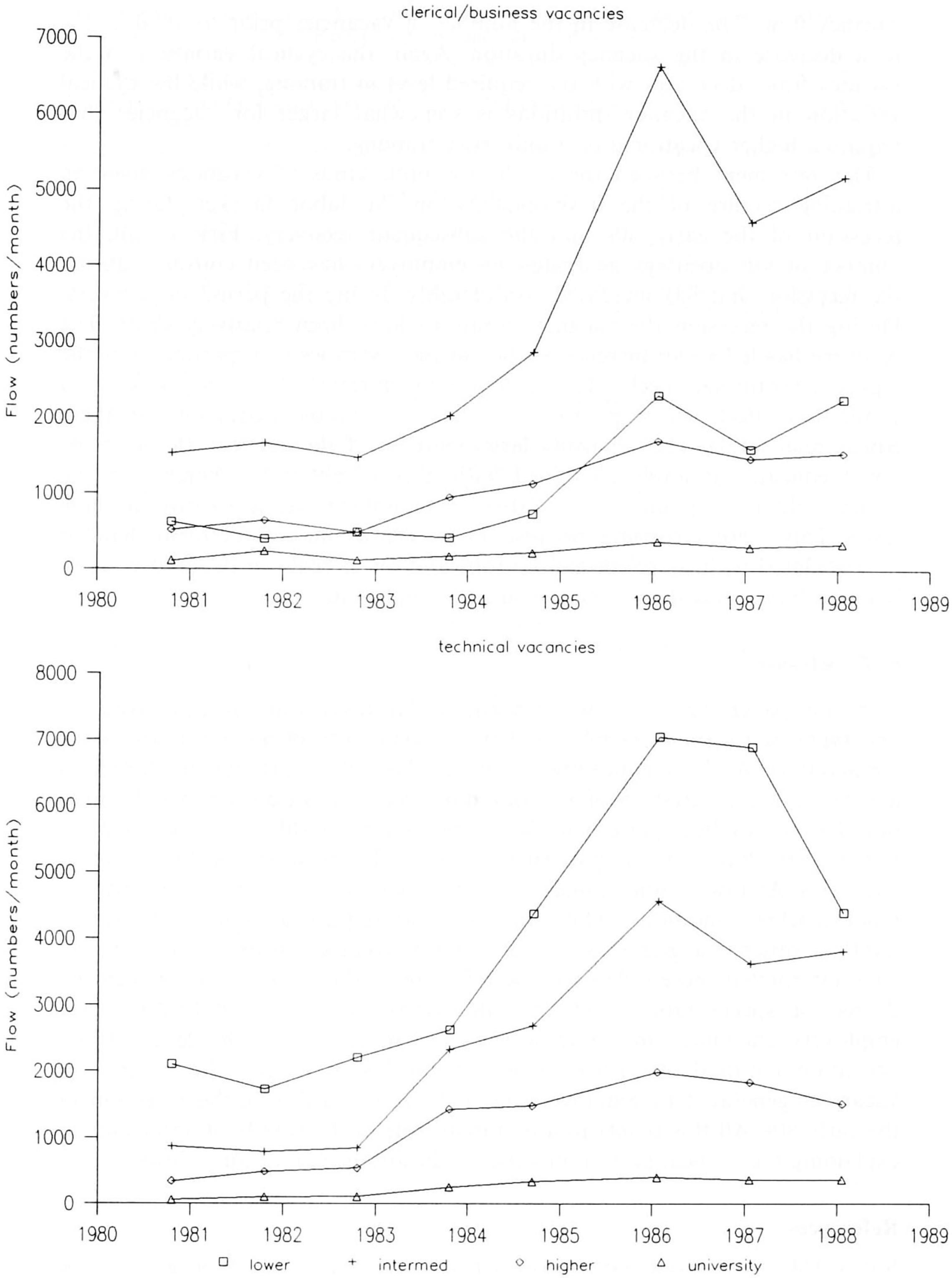

Fig. 3. Flows of clerical/business (a) and technical (b) vacancies by educational level (numbers/month).

vacancy flow. The decrease in the number of vacancies prior to 1980 is due to a decrease in the vacancy duration. Again the cyclical variation in the vacancy flows decreases with the required level of training, while the cyclical variation in the vacancy durations is somewhat larger for vacancies that require a higher vocational or a university training.

The agreement between the results for both kinds of vacancies gives an intriguing picture of the developments on the labor market during the recession of the early 80s and the subsequent recovery. First of all, the number of job openings generated by employers has been constant during the recession and has increased considerably during the period of recovery. During the recession the vacancy durations have been relatively short. The recovery has led to an increase of the vacancy durations, in particular at the higher educational levels. This increase in duration is mainly due to a congestion effect which points at a lack of suitable applicants at these educational levels. The relatively large increase of the vacancy flows at the lower educational levels combined with a relatively small increase in the vacancy duration points at a relative large number of applicants at these levels. This is not surprising, because higher educational requirements tend to be associated with more specialized jobs and an increase in demand is more likely to be frustrated by a lack of suitable applicants.

6. Conclusion

In this paper we have studied vacancy durations and vacancy flows for two types of vacancies which account for some 60% of all vacancies in the Netherlands. We have concentrated on the effect of educational requirements and the cyclical variation of vacancy durations and vacancy flows. It turns out that the cyclical pattern in flows and durations differs between educational levels, but that this pattern is quite similar between the two types of vacancies. At lower educational levels the vacancy flow is more sensitive to labor market conditions, while for jobs that require a higher educational level we observe a greater sensitivity of the average vacancy duration. We have interpreted these differences by referring to the association between the degree of specialization and the educational level. The difficulties that employers encounter in filling a vacancy increase with the level of the education required. A rather surprising conclusion is that the number of vacancies generated by employers has not decreased during the recession in the early 80s. All this points to a dominant role of the supply of applicants in explaining the cyclical pattern of vacancy durations and vacancy flows.

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